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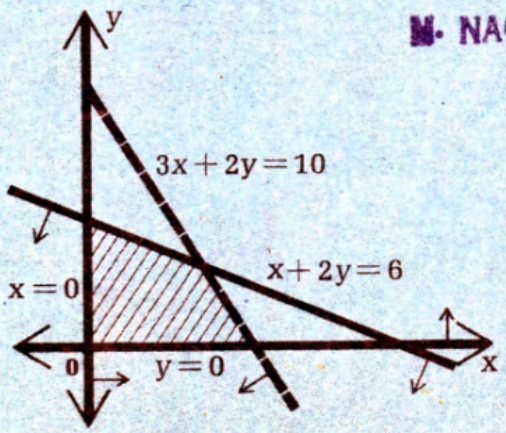

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FORMULAE EMPLOYED IN BANKING

M. NAGARAJ VARMA

Everyone knows that Banks accept deposits of cash from public and also lend money to the members of the public at specific rates of interest. In this article are discussed various deposit schemes and mathematical formulae employed by banks.

Whenever a customer goes to a bank to deposit some amount he asks the Bank Manager what amount shall he get after the stipulated period (On maturity). The Banker gives him the figure after looking into a table. Most of the customers do not know how these figures were arrived at, specially in the case of Recurring deposits. In fact the Banker himself may not know the formulae by which those figures had been calculated. The Banker merely refers to the Tables or Master charts supplied by Reserve Bank or Indian Banks Association. In case, there is a printing mistake in the tables, neither the Banker nor the customer can suspect. They cannot rectify it. This article is intended to educate both the Banker and the customer how the interest on various deposits are calculated using mathematical formulae.

Deposits in a Bank can be broadly classified into two categories.

(1) Demand deposits and (2) Term deposits.

Demand deposits are the deposits that are payable to customer whenever they demand. Term deposits are the deposits that have to be kept with the Bank for cetain specific periods and no withdrawls are be allowed before the expiry of such periods unless for a 'once-for-all closure' of the deposit prematurely. For Term deposits interest is compounded quarterly.

DEMAND DEPOSITS

Current accont:- This type of account is meant for Business concerns and no interests is paid on the amounts kept in them. This type of account is merely a way of keeping accounts of Business firms.

Savings Bank Account:- Any Individual can open and operate this type of account. Interest is paid by the bank on the lowest balance maintained between the 10th and last working day of each month. Interest is compounded half yearly. Not more than 50 withdrawls are allowed in each half-year. Withdrawal can be done at any time.

Call Deposits:- In this type of deposit amont is deposited intially and no further operations are allowed and no interest is paid on the deposit. The deposit can be withdrawn as a whole at any time.

TERM DEPOSITS

Fixed Deposit:- In this type of Dpsoit one has to keep certain amont undrawn for a fixed period and no withdrawal of prinicipal is allowed in-between unless it is a 'once for all' settlement. In this Deposit interest is credited to the account holder quarterly, half yearly and yearly at simple interest rates. Every one knows about this simple interest formula.

Simple Interest, $I = (P/100) \times T \times R$

But if one wants to withdraw interest monthly, he will get a little less amount than the amount he normally gets for a month. Generally to get monthly interest on fixed deposits, standing instructions are given to credit the monthly interest to S B A/c or RD A/c. Thus the interest thus creditied earns interest from the succeeding month onwards in the SB A/C or RD A/C as the case may be. Hence, in order to pay interest uniformly and to avoid multiple interest payment, for monthly payments of interest the 'DISCOUNTED RATE' is applied.

The discounted interest formula is,

$$D = \frac{3600\ PR}{[(R + 1200)(R + 2400) + 1440000]}$$

where, D is Discounted Monthly Interest Payable, P is Principal and R is the normal Rate of Interest.

REINVESTMENT DEPOSIT

In this type of deposit one has to keep certain amount (in multiples of 50) for a fixed period and no withdrawal of principal and Interest is allowed during the period unless it is a settlement once for all. Interest is compounded Quaterly and pricipal as well as Interst will be paid after the end of fixe period (minimum one year) ie on maturity. This amount is called "Maturity value". The interest at every quarter is re-invested as principal and hence the name "Reinvestment deposit".

The formula for the Maturity Value is the usual compound interest formula. Since Interest is compounded Quarterly the formula is,

$$M = P\ (1 + R/400)^N$$

Where, M is Maturity value, R is annual Rate of Interest and N is number of Quarters.

CASH CERTIFICATES

This scheme is the same as Reivestment scheme. But with only one difference. It is in the amount of Prinicipal. In Reinvestment plan one has to keep a round figure amount (with a minimum of 100 and above in multiples of 50) as Principal and on maturity the amount will become an odd figure.

For example Rs.5000 become Rs.10125 in 61/2 years.

Contrary to this, for cash certificates one has to tender money in odd figure which on Maturity grows to a round figure.

For example Rs.3379 become Rs. 10000 in 10 years.

Here Maturity value is called "Face value" and the pricipal is called "Issue Price" of the cash certificate. In reinvestment the principal is the "Face Value".

The formula for face value is the same as the formula for Maturity value of Reinvesttment scheme.

RECURRING DEPOSIT (RD)

This deposit scheme is the novel and ideal. In this scheme, the principal amount is not paid at a time at the begining (opening date) as in Fixed and Reinvestment schemes. Here the prinicipal is a

Recurring one. That is, one has to deposit small fixed amount each month (hence the name recurring) for a fixed period. Thus the principal grows every month and on Maturity it grows to a large sum due to quarterly compounding of interest. This sum (Maturity value) is paid on Maturity.

A minimum of Rs. 5 can be deposited every month for a minimum period of one year.

The author has found a formula for the Maturity value for this RD scheme which is the quite complicated ,

$$M = \frac{2A(R + 600)[(1 + R/400)^N - 1]}{R}$$

Where M is Maturity value, A is Monthly Instalment, R is Rate of Interest and N is Period in number of quarters,

Reckoners and Master charts are supplied to Banks by I.B.A. to facilitate finding Maturity values easily. In these tables Maturity values for various periods are given for the standard instalment of Rs.5.

PENSION SCHEME

In this scheme, the Maturity value of a Recurring deposit is kept as a Fixed deposit and the Monthly discounted Interest there on is paid monthly as pension. This is called the pension scheme.

The monthly pension scheme formula is

$$P = \frac{7200A(R + 600)[(1 + R/400)^N - 1]}{[(R + 1200)(R + 2400) + 1440000]}$$

Where, P is Monthly pension payable to customers, A is Monthly instalments of RD paid by customer, R is Rate of Interest and N is Period of RD in number of quarters.

BANK LOANS

When a Bank sanctions a Loan to a Borrower it invariably means that the loan must be repaid with interest in specified number of instalments, depending upon the purpose for which loan is allowed and the repayable capacity of the borrower, the repayment period is fixed as certain number of monthly, quarterly, half yearly or yearly instalments. Generally for most of loans bankers prefer monthly instalments.

As stated at the begining, finding the correct instalment of loan with interest is a difficult task. The author has found the follwing formula:

$$I = \frac{LR(1 + R/400)^N}{2(R + 600)[(1 + R/400)^N - 1]}$$

Where, L is loan amount, R is Rate of Interest, N is Period in number of quarters and I is Monthly Instalment of repayment.

This formula will satisfy most borrowers, since, generally borrowers do not like to pay interest separately of principal. This formula yields instalment for principal and interest together. But since the charges such as stamp cost, Insurance premium and other charges will not be known at the time of allowing loan, it is not possible to find a formula that yields an Instalment inclusive of all such charges.

To the esteemed Internet Archives

Friends,I created this Article in 1986, and this was published in "Mathematics Today" journal in the

1987 January issue. It was about Twentieth century banking when the Banks were charging interest on quarterly compounding basis for all Loans and offering Interest on deposits also on quarterly compounding basis. All the deposit formulas given by me are Absolutely correct but the formula for Loan Installment (EMI) was an approximate Formula. Now I am giving below the Absolute Formula for that Twentieth century banking quarterly compounding interest basis monthly installment formula.

$$I = \frac{LR(1+R\div400)^{N}}{(R+1200)[\{(1+R\div400)^{N}\} - 1]}$$

L= Quantum of Loan

R= Rate of interest

N = Total period of Loan in integral number of Quarters

I = Equated monthly installments (EMI)

Thanking you all.

Postscript :- In this modern Twenty-first century Banks are charging Monthly compounding basis interest but for Deposits the same quarterly compounding basis.